2.4 Summary of Findings and Comparison of the Proposed Action and the No-Action Alternative

This section summarizes and compares the potential environmental impacts of the Proposed Action and the No-Action Alternative (Section 2.2). Detailed descriptions of the impact analyses are contained in the following chapters:

- Chapter 4 describes the short-term environmental impacts associated with construction, operation and monitoring, and closure of the repository and includes the manufacture of waste disposal containers and shipping casks.
- Chapter 5 describes long-term (postclosure) environmental impacts from the disposal of spent nuclear fuel and high-level radioactive waste in the repository.
- Chapter 6 describes the impacts associated with the transportation of spent nuclear fuel, high-level radioactive waste, other materials, and personnel to and from the repository.
- Chapter 7 describes the short-term and long-term impacts associated with the No-Action Alternative.

This EIS defines *short-term impacts* as those that would occur until and during the closure of the repository and *long-term impacts* as those that would occur after repository closure and for as long as 10,000 years.

This section summarizes the findings of the EIS analyses and contains:

- A general comparison of the impacts of the Proposed Action and No-Action Alternative (Section 2.4.1), with an overall summary of the health impacts
- Short-term impacts of repository construction, operation and monitoring, and closure, including impacts for the operating modes analyzed and short-term impacts of the No-Action Alternative (Section 2.4.2)
- Long-term impacts of the Proposed Action and No-Action Alternative (Section 2.4.3)
- Impacts associated with the transportation scenarios and implementing alternatives (Section 2.4.4)

2.4.1 COMPARISON OF PROPOSED ACTION AND NO-ACTION ALTERNATIVE

In general, the EIS analyses showed that the environmental impacts associated with the Proposed Action would be small to moderate, as described in Chapters 4, 5, 6, and 8. For some of the resource areas specifically analyzed in this study, there would be no impacts. Table 2-7 provides an overview approach to comparing the range of impacts for the Proposed Action (divided into repository, combined national and Nevada transportation, and long-term impacts) and the No-Action Alternative (divided into short-term and the two No-Action long-term scenarios). The sections of the EIS where the reader may find more information about the impacts are noted.

Although generally small, environmental impacts would occur under the Proposed Action. DOE would reduce or eliminate many such impacts with mitigation measures (see Chapter 9) or implementation of standard Best Management Practices (see Chapter 9). Under the No-Action Alternative, the short-term impacts would be the same under Scenario 1 or 2. Under Scenario 1, DOE would continue to manage spent nuclear fuel and high-level radioactive waste facilities at 5 DOE sites, and commercial utilities would continue to manage their spent nuclear fuel at 72 sites on a long-term basis and to isolate the

Table 2-7. Impacts associated with the Proposed Action and No-Action Alternative[a] (page 1 of 4).

Resource area	Flexible design potential operating modes–range of impacts: Short-term (through closure): Repository	Flexible design potential operating modes–range of impacts: Short-term (through closure): Transportation	Flexible design potential operating modes–range of impacts: Long-term (after closure, to 10,000 years)	No-Action Alternative: Short-term (100 years)	No-Action Alternative: Long-term (100 to 10,000 years): Scenario 1	No-Action Alternative: Long-term (100 to 10,000 years): Scenario 2
Land use and ownership	Small; the flexible design range of disturbed land is from 4.3 km^2[b] to about 6.0 km^2 of the 600 km^2 that comprise the analyzed withdrawal area See Section 4.1.1.2	Small to moderate; 0 to about 20 km^2 of land disturbed for new transportation routes; Air Force identified Nellis Air Force Range conflicts for some routes; some routes pass close to or through Wilderness Study Areas; some corridors could directly impact Native Americans and Indian reservations; and one corridor could conflict with the Ivanpah Airport construction and operation See Section 2.4.4 and Chapter 6	Small; potential for limited access into the area; the only surface features remaining would be markers See Section 5.0	Small; storage would continue at existing sites See Section 7.2.1.1	Small; storage would continue at existing sites See Section 7.2.1.1	Large; potential contamination of 0.04 to 0.4 km^2 surrounding each of the 72 commercial and 5 DOE sites See Section 7.2.2.1
Air quality	Small; releases and exposures well below regulatory limits (less than 6 percent of limits) See Section 4.1.2.5	Small; releases and exposures below regulatory limits; pollutants from vehicle traffic and trains would be small in comparison to other national vehicle and train traffic; Clean Air Act General Conformity Requirements might apply in Clark County Nevada See Section 2.4.4, Tables 2-10 and 2-11, and Chapter 6	Very small, 5.3×10^{-10} latent cancer fatalities peak effect See Section 5.5.2	Small; releases and exposures well below regulatory limits See Section 7.2.1.2	Small; releases and exposures well below regulatory limits See Section 7.2.1.2	Small; degraded facilities would preclude large atmospheric releases See Section 7.2.2.2
Hydrology (groundwater and surface water)	Groundwater–small; water demand (230 to 290 acre-feet[c] per year) well below lowest estimate of the groundwater basin's perennial yield (580 acre-feet) See Section 4.1.3.3	Small; withdrawal of up to 710 acre-feet from multiple wells and hydrographic areas over about 4 years See Section 2.4.4 and Chapter 6	Small amounts of contamination of groundwater in Amargosa Valley during the first 10,000 years. Contamination is several hundred thousand times less than the groundwater protection standard in 40 CFR 197 See Section 5.4.2.1	Small; usage would be small in comparison to other site use See Section 7.2.1.3.2	Small; usage would be small in comparison to other site use See Section 7.2.1.3.2	Large; potential for radiological contamination of groundwater around 72 commercial and 5 DOE sites See Section 7.2.2.3.2
	Surface water–small; new land disturbance of 2.8 to 4.5 square kilometers would result in minor changes to runoff and infiltration rates; floodplain assessment concluded impacts would be small See Section 4.1.3.2	Small; minor changes to runoff and infiltration rates; all rail corridors pass through areas of identified 100-year flood zones, additional floodplain assessments would be performed in the future as necessary See Section 2.4.4 and Chapter 6	Small; minor changes to runoff and infiltration rates See Section 5.0	Small; minor changes to runoff and infiltration rates See Section 7.2.1.3.1	Small; minor changes to runoff and infiltration rates See Section 7.2.1.3.1	Large; potential for radiological releases and contamination of drainage basins downstream of 72 commercial and 5 DOE sites (concentrations potentially exceeding current regulatory limits) See Section 7.2.2.3.1

Table 2-7. Impacts associated with the Proposed Action and No-Action Alternative[a] (page 2 of 4).

Resource area	Flexible design potential operating modes–range of impacts: Short-term (through closure): Repository	Flexible design potential operating modes–range of impacts: Short-term (through closure): Transportation	Flexible design potential operating modes–range of impacts: Long-term (after closure, to 10,000 years)	No-Action Alternative: Short-term (100 years)	No-Action Alternative: Long-term (100 to 10,000 years): Scenario 1	No-Action Alternative: Long-term (100 to 10,000 years): Scenario 2
Biological resources and soils	Small to moderate; loss of about 4.3 km^2 to 6.0 km^2 of desert soil, habitat, and vegetation; adverse impacts to individual threatened desert tortoises (not the species as a whole); reasonable and prudent measures to minimize impacts; impacts to other plants and animals and habitat small; wetlands assessment concluded impacts would be small See Section 4.1.4	Small to moderate; loss of 0 to 20 km^2 of desert soil, habitat, and vegetation for heavy-haul routes and rail corridors; adverse impacts to individual threatened desert tortoises (not the species as a whole); reasonable and prudent measures to minimize impacts; impacts to other plants and animals and habitat small; additional wetlands assessments would be performed in the future as necessary prior to any construction See Section 2.4.4 and Chapter 6	Small; slight increase in temperature of surface soil directly over the repository for 10,000 years resulting in a potential temporary shift in plant and animal communities in this small area (about 8 km^2) See Section 5.0	Small; storage would continue at existing sites See Section 7.2.1.4	Small; storage would continue at existing sites See Section 7.2.1.4	Large; potential adverse impacts at each of the 77 sites from subsurface contamination of 0.04 to 0.4 km^2 See Section 7.2.2.4
Cultural resources	Small to moderate; repository development would disturb up to about 4.5 km^2 of previously undisturbed land; mitigation measures would avoid or minimize damage to and illicit collecting at archaeological sites; programs in place to minimize impacts; opposing Native American viewpoint See Section 4.1.5.2	Small to moderate; loss of 0 to 20 km^2 of land disturbed for new transportation routes; mitigation measures would avoid or minimize damage to and illicit collecting at archaeological sites; programs in place to minimize impacts; opposing Native American viewpoint See Section 2.4.4 and Chapter 6	Small; potential for limited access into the area; opposing Native American viewpoint See Section 5.0	Small; storage would continue at existing sites; limited potential of disturbing sites See Section 7.2.1.5	Small; storage would continue at existing sites; limited potential of disturbing sites See Section 7.2.1.5	Small; no construction or operation activities; no impacts See Section 7.2.2
Socioeconomics	Small; estimated peak total employment of 3,400 occurring in 2006 would result in less than a 1 percent increase in composite regional employment; therefore, impacts would be small. Estimated peak direct employment for the repository during construction would be approximately 1,900 in 2006. See Sections 4.1.6.2.1 and 4.1.6.3	Small; employment increases would range from less than 1 percent to 4.9 percent (use of intermodal transfer station in Lincoln County) of employment in affected counties See Section 2.4.4 and Chapter 6	Small; no workers, no impact See Section 5.0	Small; population and employment changes would be small compared to totals in the regions See Section 7.2.1.6	Small; population and employment changes would be small compared to totals in the regions See Section 7.2.1.6	Small; no workers; no impacts See Section 7.2.2
Occupational and public health and safety						
Public						
Radiological[d]						
MEI (probability of an LCF)	1.6×10^{-5} to 3.1×10^{-5} See Section 4.1.7.5.3	1.4×10^{-4} to 1.2×10^{-3} See Sections 6.1.1 and 6.2.3.2	4×10^{-10} to 4×10^{-9} at the boundary of the controlled area (approximately 18 km south of the repository) See Sections 5.4.2.1 and 5.4.2.2	4.3×10^{-6} See Section 7.2.1.7.3	1.3×10^{-6} See Section 7.2.1.7.3	(e)
Population (LCFs)	0.46 to 2.0 See Section 4.1.7.5.2	0.61 to 2.5 See Section 6.1.1	2×10^{-6} to 3×10^{-4} See Sections 5.4.2.1 and 5.4.2.2	0.41 See Section 7.2.1.7.3	3 See Section 7.2.1.7.3	3,300[f] See Section 7.2.2.5.3

Table 2-7. Impacts associated with the Proposed Action and No-Action Alternative[a] (page 3 of 4).

Resource area	Flexible design potential operating modes–range of impacts: Short-term (through closure) Repository	Flexible design potential operating modes–range of impacts: Short-term (through closure) Transportation	Flexible design potential operating modes–range of impacts: Long-term (after closure, to 10,000 years)	No-Action Alternative: Short-term (100 years)	No-Action Alternative: Long-term (100 to 10,000 years) Scenario 1	No-Action Alternative: Long-term (100 to 10,000 years) Scenario 2
Occupational and public health and safety (continued)						
Nonradiological (fatalities due to emissions)	Small; exposures well below regulatory limits See Section 4.1.7	1.6 to 2.8[g] See Sections 6.1.1, 6.1.3, 6.3.2.2.5.6, and 6.3.3.2.1.5	Small; exposures well below regulatory limits or guidelines See Section 5.0	Small; exposures well below regulatory limits or guidelines See Section 7.2.1.7.1	Small; exposures well below regulatory limits or guidelines See Section 7.2.1.7.1	Moderate to large; substantial increases in releases of hazardous substances in the spent nuclear fuel and high-level radioactive waste and exposures to the public See Section 7.2.2
Workers (involved and noninvolved)						
Radiological (LCFs)	4.0 to 6.8 See Section 4.1.7.5.2	3.2 to 11.7 See Section 6.1.1	No workers, no impacts See Section 5.0	16 See Section 7.2.1.7.3	10 See Section 7.2.1.7.3	No workers, no impacts See Section 7.2.2
Nonradiological fatalities (includes commuting traffic fatalities)	2.0 to 3.3 See Section 4.1.7.5.1	12 to 23[h] See Sections 6.1.1, 6.1.3, 6.3.2.2.5.6, and 6.3.3.2.1.5	No workers, no impacts See Section 5.0	9 See Section 7.2.1.7.2 and 7.2.1.14	1,080 See Section 7.2.1.7.2 and 7.2.1.14	No workers, no impacts See Section 7.2.2
Accidents						
Public						
Radiological						
MEI (probability of an LCF)	2.9×10^{-13} to 1.9×10^{-5} See Section 4.1.8.1	0.0015 to 0.015 See Section 6.1.1	Not applicable See Section 5.0	No impacts See Section 7.2.1.8	No impacts See Section 7.2.1.8	Not applicable See Section 7.2.2.7
Population (LCFs)	1.4×10^{-11} to 1.1×10^{-2} See Section 4.1.8.1	0.55 to 5 See Section 6.1.1	Not applicable See Section 5.0	No impacts See Section 7.2.1.8	No impacts See Section 7.2.1.8	3 to 13 See Section 7.2.2.7
Workers	Large; for some unlikely accident scenarios workers would likely be severely injured or killed See Section 4.1.8.1	Large; for some unlikely accident scenarios workers would likely be severely injured or killed See Section 2.4.4 and Chapter 6	No workers, no impacts See Section 5.0	Large; for some unlikely accident scenarios workers would likely be severely injured or killed See Section 7.2.1.8	Large; for some unlikely accident scenarios workers would likely be severely injured or killed See Section 7.2.1.8	Small; no workers; no impacts See Section 7.2.2
Noise/Ground Vibration	Small; impacts to public would be low due to large distances to residences; workers exposed to elevated noise levels – controls and protection used as necessary See Section 4.1.9.2	Small to moderate; transient and not excessive, less noise than 90 dBA[i]; ground vibration infrequent and less than 88 dBV at 25 m See Section 2.4.4 and Chapter 6	Small; no activities, therefore, no noise or ground vibration See Section 5.0	Small; transient and not excessive, less than 90 dBA See Section 7.2.1.9	Small; transient and not excessive, less than 90 dBA See Section 7.2.1.9	Small; no activities, therefore, no noise See Section 7.2.2

Table 2-7. Impacts associated with the Proposed Action and No-Action Alternative[a] (page 4 of 4).

	Flexible design potential operating modes – range of impacts			No-Action Alternative		
	Short-term (through closure)		Long-term (after closure, to 10,000 years)	Short-term	Long-term (100 to 10,000 years)	
Resource area	Repository	Transportation		(100 years)	Scenario 1	Scenario 2
Aesthetics	Small; low adverse impacts to aesthetic or visual resources in the area. There may be increase in lighting impacts due to lighting associated with the ventilation system See Section 4.1.10	Small; possible temporary and transient; conflict with visual resource management goals for Wilson Pass Option of the Jean rail corridor; and discernible impacts from the Caliente Intermodal transfer facility near Kershaw-Ryan State Park. See Section 2.4.4 and Section 6.2	Small; only surface features remaining would be markers See Section 5.0	Small; storage would continue at existing sites; expansion as needed See Section 7.2.1.10	Small; storage would continue at existing sites; expansion as needed See Section 7.2.1.10	Small; aesthetic value decreases as facilities degrade See Section 7.2.2
Utilities, energy, materials, and site services	Small; use of materials would be very small in comparison to amounts used in the region; electric power delivery system to the Yucca Mountain site would have to be enhanced See Section 4.1.11.2	Small; use of materials and energy would be small in comparison to amounts used nationally See Section 2.4.4 and Chapter 6	Small; no use of materials or energy See Section 5.0	Small; materials and energy use would be small compared to total site use See Section 7.2.1.11	Small; materials and energy use would be small compared to total site use See Section 7.2.1.11	Small; no use of materials or energy See Section 7.2.2
Management of site-generated waste and hazardous materials	Small; radioactive and hazardous waste generated would be a few percent of existing offsite capacity; other wastes would be managed onsite See Section 4.1.12.2	Small; waste generated would be a fraction of existing offsite capacity See Section 2.4.4 and Chapter 6	Small; no waste generated or hazardous materials used See Section 5.0	Small; waste generated and materials used would be small compared to total site generation and use See Section 7.2.1.12	Small; waste generated and materials used would be small compared to total site generation and use See Section 7.2.1.12	Small; no waste generated or hazardous materials used See Section 7.2.2
Environmental justice	Small; no disproportionately high and adverse impacts to minority or low-income populations; opposing Native American viewpoint See Section 4.1.13	Small; no disproportionately high and adverse impacts to minority or low-income populations; opposing Native American viewpoint See Section 6.1.2.12	Small; no disproportionately high and adverse impacts to minority or low-income populations; opposing Native American viewpoint See Section 5.0	Small; no disproportionately high and adverse impacts to minority or low-income populations See Section 7.2.1.13	Small; no disproportionately high and adverse impacts to minority or low-income populations See Section 7.2.1.13	Large; potential for disproportionately high and adverse impacts to minority or low-income populations See Section 7.2.2.8

a. Ranges might differ from simple addition of the minimum and maximum values listed for the constituent phases because these values might not correspond between different phases. For example, a scenario that maximizes impacts during construction could result in minimal impacts during operations.

b. km^2 = square kilometers; to convert to acres, multiply by 247.1.

c. To convert acre-feet to cubic meters, multiply by 1233.49.

d. LCF = latent cancer fatality; MEI = maximally exposed individual.

e. With no effective institutional controls, the maximally exposed individual could receive a fatal dose of radiation within a few weeks to months. Death would be caused by acute direct radiation exposure.

f. Downstream exposed population of approximately 3.9 billion over 10,000 years.

g. Nonradiological fatalities due to exhaust emissions health effects from spent nuclear fuel and high-level radioactive waste transportation, including loadout; exhaust emissions health effects from commuter and materials transportation for repository construction, operation, and closure; and rail line or heavy-haul truck/intermodal transfer station construction, maintenance, and operation.

h. Nonradiological traffic fatalities from spent nuclear fuel and high-level radioactive waste transportation and commuter traffic fatalities. As many as 10 to 17 of these fatalities could be members of the public.

i. dBA = *A-weighted decibels*, a common sound measurement. A-weighting accounts for the fact that the human ear responds more effectively to some pitches than to others. Higher pitches receive less weighting than lower ones.

material from human access with institutional control. Under Scenario 2, with the assumption of no effective institutional control after 100 years, the spent nuclear fuel and high-level radioactive waste storage facilities would begin to deteriorate and radioactive materials could escape to the environment, contaminating the local atmosphere, soils, surface water, and groundwater, thereby representing a considerable human health risk. As described in Chapter 7, if DOE increased the assumed institutional control period to be consistent with the repository preclosure period (100 to 324 years), the short-term impacts would range up to three times those reported for the No-Action Alternative, depending on the environmental resource area evaluated.

The range of potential health impacts for the Proposed Action, depending on the operating mode, and for the No-Action Alternative are shown in Table 2-8. The transportation-related impacts presented in Table 2-8 represent those associated with the preferred transportation mode (mostly rail). The range of health impacts to workers and the public for repository construction, operation and monitoring, and closure including the full range of possible transportation scenarios and modes would be 24 to 49 fatalities (see Table 2-7), whereas the health impacts for repository construction, operation and monitoring, and closure using the preferred mode of transportation (mostly rail) would be 24 to 38 fatalities (see Table 2-8).

2.4.2 SHORT-TERM IMPACTS OF THE PROPOSED ACTION REPOSITORY CONSTRUCTION, OPERATION AND MONITORING, AND CLOSURE AND NO-ACTION ALTERNATIVE

DOE analyzed short-term impacts (project start to the end of closure) for the Proposed Action and No-Action Alternative in various resource areas. The information presented in Table 2-7 shows that the short-term environmental impacts for the Proposed Action and the No-Action Alternative would generally be small and do not differentiate dramatically between the two alternatives. The analyses also included cost estimates for the two alternatives. Estimated short-term (to the end of closure) costs (in 2001 dollars) for the Proposed Action would range from $43 to $58 billion, and those for the No-Action Alternative would be as much as $61 billion for the same period (see Sections 2.1.5 and 2.2.3).

To construct the analytical basis for evaluation of repository impacts, DOE used widely accepted analytical tools to estimate potential environmental impacts, coupled with the best available information, and cautious but reasonable assumptions where uncertainties exist. This included applying conservative assumptions to the set of reasonable operating scenarios identified in the Science and Engineering Report (DIRS 153849-DOE 2001, p. 2-24) to ensure that the EIS did not underestimate potential environmental impacts and to accommodate the greatest range of potential future actions.

DOE has established parameters for the range of potential repository operating modes and has identified these parameters and their ranges in Table 2-2. These operating modes provide the basis for evaluation of the environmental impacts described in Chapter 4. Ensuring that the range of potential impacts evaluated fully encompasses the impacts that could occur under any reasonable repository mode of operation requires a basic understanding of how the particular impacts relate to the various parameters, particularly those parameters that could be varied to achieve lower-temperature operation.

As shown in the Draft EIS and the Supplement to the Draft EIS, the short-term impacts (preclosure) would increase with the size of the repository and surface facilities. The smallest repository and surface facilities are associated with the higher-temperature repository operating mode and therefore would result in the lowest short-term environmental impacts. As detailed in Section 2.1.1.2.2, the lower-temperature repository operating mode would be achieved by varying several of the design parameters independently or in combination, for differing effects. Design parameters include waste package loading, repository ventilation duration, and waste package spacing. In the analyses, DOE maximized each of these parameters in turn, and assumed reasonably conservative values for the other dependent parameters to

Table 2-8. Health and safety impact comparison of Proposed Action to No-Action Alternative.[a]

Proposed Action impacts (0 to 10,000 years) Impacts for the preclosure period (up to 341 years)		No-Action impacts (0 to 10,000 years) Impacts from 0 to 100 years	
Radiological		Radiological	
Loadout and transportation of SNF and HLW	4 LCFs	Loadout and transportation of SNF and HLW	0 LCFs
Construction and operations at repository	4 - 8 LCFs	Construction and operations	16 LCFs
Subtotal	8 - 12 LCFs	Subtotal	16 LCFs
Nonradiological		Nonradiological	
Transportation via mostly rail		Transportation (materials and commuting)	7 fatalities
SNF and HLW to Yucca Mountain	3 - 4 fatalities	Construction and operations	2 fatalities
Nevada railroad construction and maintenance	1 - 2 fatalities	Subtotal	9 fatalities
Repository construction, operation and monitoring, and closure	10 - 17 fatalities		
Construction and operations at repository	2 - 3		
Subtotal	16 - 26 fatalities		
Total (preclosure period)	***24 - 38 fatalities or LCFs***	***Total (0 to 100 years)***	***25 fatalities or LCFs***
		Impacts from 100 to 10,000 years	
Impacts from closure to 10,000 years		With institutional control	No institutional control
Radiological	~0 LCF	~13 LCFs	~3,300 LCFs
Transportation	0 fatalities	~760 fatalities	0 fatalities
Construction and operations	0 fatalities	~320 fatalities	0 fatalities
Total (0 to 10,000 years)	***24 - 38 fatalities or LCFs***	***~1,120 fatalities or LCFs***	***~3,325 fatalities or LCFs***

a. Abbreviations: SNF = spent nuclear fuel; HLW = high-level radioactive waste; LCF = latent cancer fatality.

evaluate the full range of potential environmental impacts. As an example, DOE considered a repository with the largest waste package spacing (6.4 meters), with and without the use of surface aging. The result was the largest repository and surface facilities and therefore the highest potential impacts for some environmental resource areas (for example, land disturbance, nonradiological air quality, and water use). Conversely, when DOE assumed the long postemplacement ventilation period (300 years), with and without the surface aging facility, the result was a repository that would be open for a longer period with higher potential for impacts to workers and release of naturally occurring radon from the open repository to the offsite public. DOE evaluated the reasonable combinations of these variable design parameters to establish the range of impacts reported in Chapter 4 and summarized in Table 2-7.

For the No-Action Alternative, short-term actions would be limited to termination of activities and reclamation at the Yucca Mountain site, as well as continued management and storage of spent nuclear fuel and high-level radioactive waste at 72 commercial and 5 DOE sites across the United States. Short-term actions at the repository would include dismantling and removal of surface structures, rehabilitating land disturbed during characterization activities, salvage of usable equipment and materials, sealing of boreholes, and grating of portals. Because the activities (for example, earth moving, facility removal, and site reclamation) would be essentially the reverse of facility construction and reclamation of the site is expected to require 1 year, DOE estimated the resultant impacts as essentially equal to 1 year of repository construction activities (see Chapter 7, Section 7.1, for more details).

For the 77 generator sites, impacts resulting from continued management and storage of spent nuclear fuel and high-level radioactive waste were estimated based on actual operational experience at DOE and commercial storage facilities. In addition, the short-term impacts for the No-Action Scenarios 1 and 2 would be essentially the same because both scenarios assume institutional controls remain in place for the first 100 years. The information in Table 2-7 generally reflects environmental impacts at the generator sites, because the short-term impacts of No-Action at the repository would be much smaller than the collective impacts at the 77 generator sites.

2.4.3 LONG-TERM IMPACTS OF THE PROPOSED ACTION AND THE NO-ACTION ALTERNATIVE

In addition to the short-term impacts described above, DOE assessed the impacts from radiological and nonradiological hazardous materials released over a much longer period (100 years to as long as 10,000 years) after the closure of the repository (for the Proposed Action, DOE also estimated the peak *dose* for the post-10,000 year period). These projections are based essentially on the best available scientific techniques. DOE focused the assessment of long-term impacts on human health, biological resources, surface-water and groundwater resources, and other resource areas for which the analysis determined the information was particularly important.

The EIS also examined possible biological impacts from the long-term production of heat by the radioactive materials disposed of in Yucca Mountain. The analysis determined that there would be small or no long-term impacts to land use, *noise*, socioeconomic resources, cultural resources, surface-water resources, aesthetics, utilities, or site services from the Proposed Action and limited impacts from the No-Action Alternative, depending on the scenario. The analysis led to the following conclusions:

- From 0.04 to 0.4 square kilometer (10 to 100 acres) of land could be contaminated to the extent it would not be usable for long periods near each of the 77 sites for No-Action Scenario 2. There could be accompanying impacts on biological resources, socioeconomic conditions, cultural resources, and aesthetic resources for long periods. Such impacts for the Proposed Action and No-Action Scenario 1 would be very small.

- For No-Action Scenario 2, there could be low levels of contamination in the surface watershed and high concentrations of contaminants in the groundwater downstream of the 77 sites for long periods. There would be no such impacts for No-Action Scenario 1. For the Proposed Action, there could be very low levels of contamination in the groundwater in the *Amargosa Desert* for a long period.

- Projected radiological impacts to the public for the first 10,000 years for the Proposed Action would be low (about 2×10^{-6} to 3×10^{-4} *latent cancer fatality* per year) compared to No-Action Scenario 2 (3,300 latent cancer fatalities over 10,000 years).

- Radionuclides would be released for a long period of time under the Proposed Action and peak doses would occur about 480,000 years after closure of the repository. The peak mean annual effective *dose equivalent* would be 120 to 150 *millirem*.

- Projected long-term (10,000 years) fatalities associated with No-Action Scenario 1 would be about 1,000, primarily to the workforce at the storage sites.

- Risks associated with sabotage and materials diversion in relation to the fissionable material stored at the 77 sites would be much greater than they would be if the fissionable material were in a monitored deep geologic repository.

The projected cost associated with No-Action Scenario 1 would range from $520 million to $570 million a year (2001 dollars) (see Section 2.2.3) for 9,900 years. Projected long-term costs for the Proposed Action would be very low while there would be none for No-Action Scenario 2 due to the lack of institutional control.

2.4.4 IMPACTS OF TRANSPORTATION SCENARIOS

Table 2-7 summarizes the full range of transportation impacts for the construction, operation and maintenance, and closure of the proposed repository, including the mostly rail and mostly legal-weight truck scenarios and the impacts of constructing and using the Nevada implementing alternatives. This range bounds the transportation-related impacts that could occur. Table 2-8 summarizes health and safety impacts for construction, operation and maintenance, and closure of the repository using the preferred transportation mode of mostly rail nationally and in the State of Nevada.

The following sections address health impacts from the movement of spent nuclear fuel and high-level radioactive waste across the Nation (Section 2.4.4.1) and impacts that could occur in the State of Nevada for the legal-weight truck, rail, and heavy-haul truck implementing alternatives (Section 2.4.4.2). The impacts discussed in both sections are included in Tables 2-7 and 2-8, and are described here to show the comparative difference between the 10 transportation implementing alternatives.

2.4.4.1 National Transportation

This section summarizes and compares national transportation-related environmental impacts for the movement of spent nuclear fuel and high-level radioactive waste from the 77 sites to the Yucca Mountain site. Table 2-9 compares the environmental impacts for the two national transportation scenarios, mostly rail and mostly legal-weight truck (see Section 2.1.3.2). Because DOE does not know the actual mix it would use for these potential national transportation modes, the analyses used these two scenarios to bound the impacts from reasonably expected transportation activities that would move spent nuclear fuel and high-level radioactive waste to the Yucca Mountain site. In addition to national impacts, Table 2-9 includes estimates of the environmental impacts associated with transportation in Nevada.

Table 2-9. National transportation impacts for the transportation of spent nuclear fuel and high-level radioactive waste for the mostly rail and mostly legal-weight truck scenarios.[a,b]

Group	Impact	Mostly legal-weight truck scenario	Mostly rail scenario
Worker	*Incident-free health impacts, radiological*		
	Maximally exposed individual (rem)	48[c]	48[c]
	Individual latent cancer fatality probability	0.02	0.02
	Collective dose (person-rem)	29,000	7,900 - 8,800
	Latent cancer fatality incidence	11.7	3.2 - 3.5[d]
	Industrial safety (fatalities)	0.9	0.29
Public	*Incident-free health impacts, radiological*		
	Average exposed individual (rem)	0.0005	0.0001
	Maximally exposed individual (rem)	2.4[e]	0.29
	Individual latent cancer fatality probability	0.0012	0.00014
	Collective dose (person-rem)	5,000	1,200 - 1,600
	Latent cancer fatality incidence	2.5	0.61 - 0.81
	Incident-free vehicle emissions impacts (fatalities)	0.95	0.55 - 0.77
	Radiological impacts from maximum reasonably foreseeable accident scenario		
	Frequency (per year)	2.3 in 10,000,000	2.8 in 10,000,000
	Maximally exposed individual (rem)	3	29
	Individual latent cancer fatality probability	0.0015	0.015
	Collective dose (person-rem)	1,100	9,900
	Latent cancer fatality incidence	0.55	5
	Accident dose risk (person-rem)	0.46	0.89
	Accident risk (latent cancer fatalities)	0.00023	0.00045
Public and transportation workers	*Fatalities from vehicular accidents*	4.9	2.3 - 3.1

a. The assumed external dose rate is 10 millirem per hour at 2 meters (6.6 feet) from the vehicle for all shipments.
b. Totals for 24 years of operation, including impacts of loading.
c. Based on 2-rem-per-year dose limit.
d. Range for the 10 rail and heavy-haul truck implementing alternatives in Nevada.
e. Based on 100-millirem-per-year dose limit.

As discussed in more detail in Chapter 6, shipments of spent nuclear fuel and high-level radioactive waste to Yucca Mountain would be a small fraction of the overall railroad and highway shipping activity in the United States. Thus, the incremental impacts from shipments to Yucca Mountain for the resource areas would be small in comparison to background impacts from all shipping activities, with the exception of potential radiological impacts.

The following conclusions can be drawn from the analysis results summarized in Table 2-9:

- Radiological impacts from maximum foreseeable accident scenarios during the transportation of spent nuclear fuel and high-level radioactive waste would be lower for the mostly legal-weight truck scenario. The likelihood that such an accident would occur is extremely small for all scenarios.

- Impacts from the transportation of spent nuclear fuel and high-level radioactive waste from the commercial and DOE sites to the Yucca Mountain site would be low for either national shipping mode.

- Radiological impacts to the public and to workers for national transportation activities would be lower for the mostly rail scenario.

2.4.4.2 Nevada Transportation

For shipments coming into the State of Nevada by rail, there is no branch rail line to connect the national rail routes with the Yucca Mountain site (see Section 2.1.3.3). As a consequence, DOE evaluated the impacts in Nevada of moving spent nuclear fuel and high-level radioactive waste to the site using 10 implementing alternatives. These included five potential corridors for a new branch rail line (see Section 2.1.3.3.2) and five potential combinations of intermodal transfer stations and highway routes for heavy-haul trucks (see Section 2.1.3.3.3).

Tables 2-10 and 2-11 compare the impacts from transportation activities in potential Nevada rail corridors and heavy-haul truck corridors, respectively, and includes the mostly legal-weight truck scenario impacts that would occur in Nevada. In addition, they list the distance of each route. The results include the potential corridor variations in the routes chosen, construction required, and operations. The impacts summarized in Tables 2-10 and 2-11 are based on the impact analyses in Chapter 6, Sections 6.3.1, 6.3.2, and 6.3.3, which delineate the corridor variations. Additional attributes such as cost, institutional acceptability of the route, construction and schedule risk, and operational compatibility could affect a decision on the choice of a transportation mode or route in Nevada.

The following conclusions can be drawn from the information in Tables 2-10 and 2-11:

- Environmental impacts for each of the 10 implementing alternatives would be small.

- With the exception of *collective dose*, the environmental impacts for shipment by legal-weight truck in Nevada would be smaller than those from the 10 implementing alternatives associated with incoming shipments by mostly rail scenario. However, even for shipment by legal-weight truck in Nevada, the projected collective dose impacts would be small (approximately 0.9 latent cancer fatality to both the public and transportation workers) over 24 years.

- With the exception of land use, differences in environmental impacts for the 10 implementing alternatives related to incoming shipments by mostly rail scenario would be small, so environmental impacts do not appear to be a major factor in the selection of transportation mode, route, or corridor in Nevada for incoming rail shipments.

- As much as about 20 square kilometers (4,900 acres) of land would be disturbed for new transportation routes. Three of the rail corridors would encroach on the western and southern boundaries of the Nellis Air Force Range. Of these three, one short segment of the Valley Modified Corridor would not have a variation that could avoid the encroachment. The Caliente-Chalk Mountain Corridor and the Caliente/Chalk Mountain heavy-haul truck route would travel directly through the range. The U.S. Air Force has stated that any route through the Range would have national security implications. Several rail corridors pass through or near Wilderness Study Areas or the proposed Ivanpah Valley Airport. Rail or heavy-haul truck routes could affect the Timbisha Shoshone trust lands, Las Vegas Paiute Reservation, or Moapa Reservation. Some routes could overlap predicted Las Vegas-area growth. Heavy-haul trucks would slow traffic flow.

- Impacts to cultural resources for any of the potential implementing alternative routes or corridors cannot be fully assessed until more detailed archaeological and ethnographic studies are conducted, but they are likely to be similar to one another. Impacts to Native American values could occur from the use of any of the routes including the use by legal-weight trucks of highways in Nevada that would pass through the Moapa and Las Vegas Paiute Indian Reservations.

2.5 Collection of Information and Analyses

DOE conducted a broad range of studies to obtain or evaluate the information needed for the assessment of Yucca Mountain as a monitored geologic repository for spent nuclear fuel and high-level radioactive waste. The Department used the information from these studies in the analyses described in this EIS. Because some of these studies are ongoing, some of the information is incomplete.